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THE ROLE OF ULTRASONOGRAPHY IN THE DETECTION OF UROLITHIASIS IN PATIENTS WITH ACUTE RENAL COLIC

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Abstract
This study was conducted to assess the diagnostic Ultrasonography compared to unenhanced helical CT scan in detecting urinary stones in patients with acute renal colic. This retrospective study comprised of 156 patients who undergo unenhanced urinary tract CT scan and ultrasonography for thought of urolithiasis. Both techniques were used to resolve the presence or absence, site, size, and number of urinary stones, as well as company of any other intra-abdominal pathology. For statistical analysis, the sensitivity, specificity, predictive values, and diagnostic accuracy of ultrasonography were deliberate considering unenhanced CT scan as a gold normal. Unpaired two-tailed student's t-test was used for judgment between mean size of true positive, false positive, and false negative stones. There were 68 patients having 115 urinary stones. Ultrasound identified 54 stones, missed 43, and falsely diagnosed 18 stones. The mean size of true positive, false positive, and false negative stones were 4.8 ± 3.3 mm, 6 ± 1.8 mm and 4.18 ± 3 mm, respectively. There were 23 patients with other intra-abdominal pathologies, equally detected by both techniques. Ultrasound helped in identifying the cause of acute flank pain in 62% of cases. The overall sensitivity, specificity, positive and negative predictive values, and correctness of ultrasonography in the diagnosis of renal stone disease were 58%, 91%, 79%, 78%, and 78%, respectively. Our study suggests that, despite its limited value in detecting urinary stones, ultrasonography should be performed as an initial assessment in patients with acute flank pain. Unenhanced helical CT should be reserved for patients in whom ultrasonography is uncertain.
Keywords: Ultrasonography, CT scan

Introduction

Acute renal colic is a common clinical problem and the investigation modalities have undergone transformation in the last decade, so that the choice of an initial diagnostic method is not always clear, particularly when there is a contraindication to radiation exposure or, to intravenous injection of iodinated contrast material. Simple radiograph of the kidney, ureters, and urinary bladder lacks sensitivity for radiolucent stones, and it is of low specificity particularly when pelvic phleboliths are present. [1] Intravenous urography was careful the radiological method of choice for a long time in patients with acute renal colic as it allows both morphological and functional evaluation of the urinary system.[2-5] It was considered to carry a low sensitivity in patients with small stones, in stones with low lessening value, and in patients with air-distended bowel.[6]

Urinary tract ultrasonography is a widely used imaging method as it is safe, rapid, comfortable to patients, and relatively of low cost compared to the IVU and the computerized tomography scan. The sensitivity of US for detection of urinary calculi is widely variable in the literature depending on the site and size of calculus, and on the patient morphology.7,8 By the end of last century, unenhanced helical CT scan (UHCT) was introduced as a new imaging modality by Smith et al9 for symbol of urinary stones, and was well accepted as an alternative method to IVU.10 Nowadays, it is considered as the imaging modality of choice for this clinical entity.11-14 Radiation dose, convenience, and high cost compared to US represent main confines of this technique. The objectives of our display study were to determine the role of B-Mode US in detecting urinary calculi and to contrast its diagnostic accuracy with the UHCT scan.

Materials and Methods

One hundred fifty six patients, who underwent UHCT scan and US for suspicion of urolithiasis from January 2008 to August 2008, were retrospectively reviewed. There were 104 male patients with a mean age of 53 ± 17 years, and 55 female patients with a mean age of 48 ± 16 years. UHCT scan was performed with a Soma tom Plus 4 machine (Siemens, Germany). The images were obtained with the patient in supine position during breath-hold plus quiet breathing. The explored area extended from the upper poles of both kidneys down to pubic symphysis using five

mm collimation with a table speed of 7.5 mm/second giving a pitch of 1.4:1.

The images were obtained with a 0.75-second gantry rotation using 120 KVp and 205 mA giving 157 mAs. Multiplanar reformation (MPR) in coronal oblique direction was used when the location of stone was uncertain. CT scan images were reported by consultant radiologists on hard copy films. Ultrasound examinations were performed by the trans-abdominal approach for all patients, after ensuring a full urinary bladder, using 3.5 or 5MHz probes. The kidneys were evaluated in the longitudinal and transverse projections.

Whenever possible, the course of ureters was also followed down to the urinary bladder with special attention to the uretero-vesical junction. The urinary bladder was also examined in both planes. Both UHCT and US were performed to determine the presence or absence, site, size, and number of urinary stones as well as presence of ureteric and/or pelvicalyceal system dilatation. Any other renal or extra-renal pathology was also registered.

The patients were confidential into three groups according to visualization of urolithiasis: Group- A with urolithiasis seen on both UHCT and US, Group-B with urolithiasis seen only on CT scan, and Group-C with urolithiasis seen only on US. The sensitivity, specificity, positive and negative predictive values, and diagnostic correctness of US were measured considering UHCT as a gold standard. Unpaired two-tailed student's t-test was used to determine the presence of statistically significant distinction in the mean size of true positive, false unconstructive and false positive stones as demonstrated on UHCT.

Results

There were 68 patients having 115 renal stones seen on either, or both techniques. There were 47 male patients with mean age of 50 ± 17 years, and 21 female patients with a mean age of 46 ± 19 years. The number of patients in Groups-A, B, and C were 34 (66 stones), 25 (33 stones), and nine patients (16 stones), respectively. Ultrasound allowed identification of 54 stones (47%): 19 out of 34 right renal stones, 24 out of 30 left renal stones, one out of 11 right ureteral stones, zero out of eight left ureteral stones, and 10 out of 14 urinary bladder stones. Ultrasound falsely demonstrated 18 stones in 11 patients: 12 stones in the right kidney, five stones in the left kidney, and one in the left ureter. The mean size of true positive, false negative, and false positive urinary stones were 4.8 ± 3.3 mm, 4.18 ± 3 mm and 6 ± 1.8 mm, respectively.

Among patients in Group-A, US detected 54 stones in 21 patients, missed 13 stones in 11 patients and falsely diagnosed two stones in two patients. The site and size of true positive stones included: 19 stones of 5.6 ± 3.2 mm in the right kidney, 24 stones of 4.8 ± 2.8 mm in the left kidney, one stone of 3 mm in the right ureter, and 10 stones of 7.9 ± 2.4 mm in the urinary bladder. The site and the mean size of missed stones were: two stones of 5 ± 4 mm in the right kidney, five stones of 4 ± 2 mm in the left kidney, four stones of 6 ± 2 mm in the right ureter, and two stones of 4 mm in the left ureter. The site and mean size of falsely diagnosed stones were one stone of 7 mm in the correct kidney, and one stone of 5 mm in the left kidney. Regarding dilatation of the ureter and/ or pelvicalyceal (PC) system, both techniques were similarly effective in all cases. They were normal and dilated in 28 and six patients, respectively. In the middle of patients in Group-B, US missed 35 stones in 27 patients. The site and mean size of the missed stones were: 11 stones of 4.6 ± 4 mm in the right kidney, eight stones of 5 ± 4.5 mm in the left kidney, six stones of 3.5 ± 2 mm in the right ureter, five stones of 3 mm in the left ureter, and three stones of 7 ± 4 mm in the urinary bladder. No false positive stones were registered in this group.

Regarding dilatation of the ureter and/or PC system, both techniques demonstrated dilated PC system in four patients and ureteral dilatation in one patient. UHCT scan only showed dilated PC system in two patients while US only showed dilated PC systems in three patients without demonstrating the cause of obstruction.

Among patients in Group-C, US falsely demonstrated 12 stones in nine patients. The site and size of these stones were: seven stones of 6 ± 2.3 mm in the right kidney, four stones of 3 ± 0.5 mm in the left kidney, and one stone of 6 mm in the left ureter. Regarding ureteric and/or PC system dilatation; US showed dilated PC system in one patient, and dilated ureteral and PC system in one other patient. In the first patient, US demonstrated a stone of 5 mm in the right kidney, and in the second patient, a stone of 6 mm at the left uretero-vesical junction. UHCT was normal in these two cases. Both techniques were equally effective in demonstrating associated intra-abdominal pathology in the three patient-groups. Renal pathology other than renal stone disease was established in 13 patients: four patients had renal mass, five patients had urinary bladder tumor, one patient had pyelo-ureteric junction obstruction, and one patient had urinoma. Extra-renal pathology was incidentally detected in 14 patients. There were seven patients with gallstones, two patients with rectal tumor, one patient with splenic infarction, one patient with ovarian cyst, and one patient with pancreatic pseudocyst.

The sensitivity, specificity, predictive values, and accuracy of B-mode US in detecting urinary stones. The sensitivity, specificity, and accuracy of US in detecting ureteral calculi were 6%, 99%, and 88%, respectively. For renal stones,

these rates were 48%, 87%, and 78%, respectively. Statistical analysis revealed a significant difference between false positive and false negative stones (P = 0.04), while no significant difference was found between true positive and false negative stones, and true positive and false positive stones (P= 0.3, and 0.16, respectively).

Discussion

The diagnosis of acute renal colic is usually based on clinical history, and physical and laboratory examinations. Radiological investigations are reserved for those with atypical history or when interventional modus operandi or follow- up examinations are required.

In this decade, UHCT has gained a big getting and is considered the imaging method of choice in many centers in patients with suspected urinary calculus. The published sensitivity and specificity of UHCT in acute ureteral colic were 96% and 100%, respectively.15 On the other hand, the use of US as a showing test in these patients has become less practiced.16

Our results and other published information demonstrated that the sensitivity and specificity of US in detecting urolithiasis were better for renal than for ureteral calculi.7,16,17 These rates in our study were 49% and 89% for renal calculi, and 6% and 99% for ureteric calculi, respectively. The US identified 64% and 59%, of right and left renal stones with a corresponding specificity of 95% and 97%, respectively and, that was superior than other reports.7, 18 The better visualization of right than left renal stones could be related to the subordinate position of the left kidney and to the interposition of splenic flexure, that may correspond to a barrier to a satisfactory hallucination of the left kidney. Although US missed 38% of renal stones and was falsely positive in 12.5% of cases, we did not find a statistically significant difference between the mean size of true positive and false negative renal stones (P = 0.3). Some authors7 found that the sensitivity of US is dependent on the size of the calculus, as the mean size of stones detected on US in their patients was advanced than that in our patients. Renal calculi can be missed on US because of absence of the characteristic associated acoustic shadowing; the mean size of renal stones in our study was relatively small. Indeed, five stones larger than 10 mm were not visualized on US and this could be correlated to either patient being overweight or, to the presence of bowel distension. Thirteen of

14 falsely diagnosed urinary stones were proved to be located in the kidneys; we think that was also related to the presence of hyperechoic foci without acoustic shadowing.

We found that US is of limited value in detecting ureteral calculi and that was in agreement with other studies.14,19 The major weak spot of US is its inability to examine the entire course of the ureter particularly in the absence of ureteral dilatation. However, US allowed exclusion of renal stone disease in 88 patients (56%) yielding a 91% specificity, and 78% accuracy.

Dilated ureteric and or PC system was identified in two patients on US without direct visualization of the obstructive agent. In these patients, UHCT scan demonstrated ureteral stones in both patients. On the other hand, dilated PC system on UHCT was shown in four patients with no evidence of obstructing agent. In one patient, US performed one week after the UHCT scan demonstrated one stone in the urinary bladder; in another patient, PUJ obstruction was diagnosed, and in the other three patients the causative agent was not identified. It is well known that dilated ureteric and PC system could be related to other non-obstructive diseases such as vesico-ureteral reflux, and malignant or inflammatory ureteral stricture.

Our results established that 67% of ureteral stones detected on UHCT and/or US were not associated with dilated PC system. It had been reported that in early obstructive uropathy, no dilatation of PC system could be found,19-21 and a lag period of three hours is usually required to build-up a significant back pressure to induce PC system dilatation. 19 The introduction of Duplex Doppler US may improve identification of ureteral obstruction by measuring the intra-renal resistive index. In a previous study, it was found that the resistive index was related to excretion delay in cases of complete obstruction, for which it was higher in non-excreting than in delayed-excreting kidneys.21 In addition, Duplex Doppler US can depict urinary obstruction earlier than B-mode US, which can miss cases of urinary obstruction without PC system dilatation.21-24 The limitations of the present study were related to its retrospective nature and to absence of a fixed imaging protocol. We think that this was responsible for high false negative rate in our study; thus, stones detected on UHCT might have been passed spontaneously at the time of US; particularly because, the mean size of uri-nary stones in our patients was less than 5 mm and studies have demonstrated that ureteral stones less than 5 mm may pass spontaneously.12,25

Both techniques were similar in identifying the presence of extra-urinary pathology, and that was in agreement with other studies.11,12,26 The prevalence of intra-abdominal pathology other than renal stone disease was 15% and that was within the wide reported range (2.5% - 57%).6,8,27,28 Five of 14 urinary bladder stones were missed on US, and this could be related to hyper distended

urinary bladder that could not be totally explored, presence of reverberation artifacts, or to small size of stones. In our study, the mean size of missed and truly diagnosed stones was 3 mm, and 9.8 mm, in that order.

Conclusion

Ultrasonography is less accurate than UHCT scan in detecting renal stone disease, and both techniques have a alike ability to detect other intra-abdominal pathology. US can depict causes of acute flank ache in 62% of cases, is usually obtainable in any radiology center and allows a safe and non-invasive examination, particularly in children and in pregnant patients. It is relatively inexpensive compared to UHCT. In our hospital, the cost of UHCT scan is five times that of US. Despite its restricted value in detecting urinary stones, we supporter the use of US as an initial screening assessment in patients with acute flank pain as it permits reducing the cost of radiological investigations by 50%. UHCT should be kept for patients in whom US is open to doubt.

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